CHAPTER = 2 **KINEMATICS**

BOOK NUMERICAL

1 A helicopter is ascending at a rate of 12m/s at height of 80m above the ground, a package is dropped. How long does the package takes to reach the ground?

Data:

For helicopter

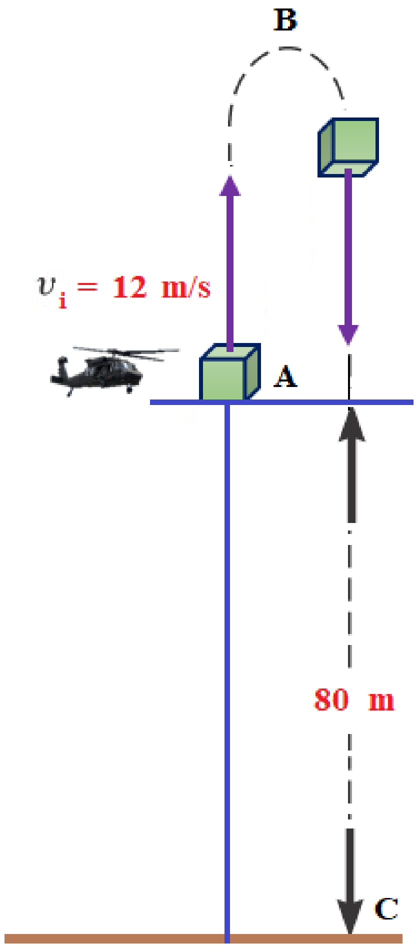
V_i = 12 m/sec,

H = 80 meters

For package

V_i = 12 m/sec

t = ? to reach the ground



Time A to B

$v_f = v_i + at$

$0 = 12 - 9.8\,t_1$

$9.8\,t_1 = 12$

$t_1 = \frac{12}{9.8}$

$t_1 = 1.22$ sec

(ii) To find height between A and B:

$$2gs = V_f^2 - V_i^2$$

$$2(-9.8)h = (0) - (12)^2$$

$$-19.6h = -144$$

$$h = \frac{144}{19.6}$$

$$h = 7.346\text{m}$$

Height point B to C

H = h + 80

H = 7.347 + 80

H = 87.347 m

Time B to C

S =H = 57.347 m

$v_i = 0$

$a = 9.8m/s^2$

$$S = v_i t + \frac{1}{2}gt^2$$

$$87.347 = (0xt) + \frac{1}{2}(9.8)t^2$$

$$\frac{87.347}{4.9} = t^2$$

$$\sqrt{\frac{87.347}{4.9}} = t$$

t_2 = 4.22 s

TOTAL TIME TAKEN

$$t = 1.22 + 4.22$$

$$t = 5.44$$

2 **Two tugboats are towing a ship, each exerts a force of 6000 N and the angle between the ropes is 60°. Calculate the resultant force on the ship.**

Data:

$F_1 = 6000$ N, $F_2 = 6000$ N

$\theta = 60°$, $F = ?$

Solution:

$$F = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos\theta}$$

$$F = \sqrt{(6000)^2 + (6000)^2 + 2(6000)(6000)\cos 60°}$$

$$F = \sqrt{36000000 + 36000000 + 72000000 \times 0.5}$$

$$F = \sqrt{36000000 + 36000000 + 36000000}$$

$$F = 10392.305N$$

3 **A car starts from rest and moves with a constant acceleration. During the 5th second of it's motion it covers a distance of 36 m, calculate:**
(i) the acceleration of the car.
(ii) the total distance covered by the car during this time.

Data:
Initial velocity $v_i = 0$
Distance covered during 5th second
$S_{5th\ sec} = 36$ m
Acceleration $a = ?$
Total distance covered $S = ?$

SOLUTION:
Let the distance covered by the car in 5 seconds be S_5 given by:

$$S_5 = v_i t + \frac{1}{2}at^2$$

$$S_5 = 0 + \frac{1}{2}a(5)^2$$

$$S_5 = 12.5\,a \text{ .... (i)}$$

Distance covered by the car in 4 sec. is given by:

$$S_4 = v_i t + \frac{1}{2}at^2$$

$$S_4 = 0 + \frac{1}{2}a(4)^2$$

$$S_4 = 8a \text{ .... (ii)}$$

Distance covered during 5th sec. will be:

$$S_5 - S_4 = 36$$

$$12.5a - 8a = 36$$

$$4.5a = 36$$

$$a = \frac{36}{4.5}$$

$$a = 8\ m/s^2$$

Total distance covered by the car is given by:

$$S = v_i t + \frac{1}{2}at^2$$

$$S = 0 + \frac{1}{2} \times 8 \times (5)^2$$

$$S = 0 + \frac{1}{2} \times 8 \times 25$$

$$S = 100\ m$$

4 **Show that the range of projectile at complementary angles are same with examples?**

The range of the projectile is given by,

$$R = \frac{V_0^2 \sin 2\theta}{g} \dots\dots\dots\dots\dots\dots\dots (i)$$

Range R is same for complementary angle of projection β and $(90^0 - \beta)$ from horizontal

For projection angle θ = β

Substituting θ = β in equation (i), we get

$$R_1 = \frac{V_0^2 \sin 2\beta}{g} \dots\dots\dots\dots\dots\dots (ii)$$

For projection angle θ = (90^0 - β)

Substituting θ =(90^0 – β) in equation (i)

$$R_2 = \frac{V_0^2 \sin 2(90-\beta)}{g}$$

$$R_2 = \frac{V_0^2 \sin (180-2\beta)}{g}$$

$$R_2 = \frac{V_0^2 (\sin 180 \cos 2\beta - \cos 180 \sin 2\beta)}{g}$$

$$R_2 = \frac{V_0^2 \{0\times \cos 2\beta - (-1) \sin 2\beta\}}{g}$$

$$R_2 = \frac{V_0^2 \{0+1 (\sin 2\beta)\}}{g}$$

$$R_2 = \frac{V_0^2 \sin 2\beta}{g} \dots\dots\dots\dots (iii)$$

Comparing equation (ii) and (iii)

$$R_1 = R_2$$

So, for two angles, β and (90 – β) the range of the projectile will be same

If θ = 30^0 $R_1 = \frac{V_0^2 \sin 2\theta}{g}$ $R_1 = \frac{V_0^2 \sin 2(30)}{g}$ $R_1 = \frac{V_0^2 \sin 60}{g}$ $R_1 = \frac{V_0^2}{g} \frac{\sqrt{3}}{2}$	**If θ = 60^0** $R_2 = \frac{V_0^2 \sin 2\theta}{g}$ $R_2 = \frac{V_0^2 \sin 2(60)}{g}$ $R_2 = \frac{V_0^2 \sin 120}{g}$ $R_2 = \frac{V_0^2}{g} \frac{\sqrt{3}}{2}$ **So, for two angles, 30^0 and $60^0$the range of the projectile will be same**

5 At what angle the range of projectile becomes equal to the height of projectile?

Ans The horizontal range is given by

$$R = \frac{v_0^2 \operatorname{Sin} 2\theta}{g} \quad \text{-----------------(i)}$$

The maximum height attained by the projectile is given by

$$h_{max} = \frac{v_0^2 \operatorname{Sin}^2\theta}{2g} \quad \text{------------- (ii)}$$

According to the given condition

maximum height of the projectile = horizontal range of the projectile

$$h_{max} = R$$

$$\frac{v_0^2 \operatorname{Sin}^2\theta}{2g} = \frac{v_0^2 \operatorname{Sin} 2\theta}{g}$$

$$\frac{v_0^2 \operatorname{Sin}\theta \operatorname{Sin}\theta}{2g} = \frac{v_0^2\, 2 \operatorname{Sin}\theta \cos\theta}{g}$$

$$\frac{\mathbf{Sin\theta}}{\mathbf{2g}} = \frac{\mathbf{2\cos\theta}}{\mathbf{g}}$$

$$\frac{\mathbf{Sin\theta}}{\mathbf{2}} = \mathbf{2\cos\theta}$$

$$\frac{\mathbf{Sin\theta}}{\mathbf{cos\theta}} = \mathbf{4}$$

$$\operatorname{Tan}\theta = \mathbf{4}$$

$$\boldsymbol{\theta} = \mathbf{tan^{-1}(4\,)}$$

$$\boldsymbol{\theta} = \mathbf{tan^{-1}(4)}$$

$$\boldsymbol{\theta} = \mathbf{75.96^0}$$

6 A marter shell is fired at a ground level target 500 m distance with an initial velocity of 90 m. What is the launch angle?

Data: R = 500m V_o = 90 m/s θ = ? g = 9.8 m / s^2 **SOLUTION:** $R = \frac{V_o^2}{g} Sin2\theta$ $500 = \frac{(90)^2}{9.8} Sin2\theta$	$500 = \frac{(90)^2}{9.8} Sin2\theta$ $\frac{500 \times 9.8}{8100} = Sin2\theta$ Sin 2θ = 0.6049 2θ = Sin^{-1} (0.6049) 2θ = 37.22° θ = 18.61° And another possible angle will be, α = 90° - 18.61° α = 71.39°

CHAPTER = 2 KINEMATICS

ADDITIONAL NUMERICAL

1 Two vectors of magnitudes 10 units and 15 units are acting at a point. The magnitude of their resultant is 20 units. Find the angle between them.

DATA

A_1 = 10 Units
A_2 = 30 Units
R = 20 N
θ = ?

SOLUTIONS

$R = \sqrt{A_1^2 + A_2^2 + 2A_1A_2 Cos\theta}$ $20 = \sqrt{(10)^2 + (15)^2 + 2(10)(15)Cos\theta°}$ **Squaring both the sides** $(20)^2 = (10)^2 + (15)^2 + 2(10)(15)Cos\theta°$ $400 = 100 + 225 + 300Cos\theta°$	$400 = 100 + 225 + 300Cos\theta°$ $400 - 325 = 300Cos\theta°$ $\frac{75}{300} = Cos\theta°$ $\theta = Cos^{-1}\left(\frac{75}{300}\right)$ $\theta = 75.5^0$

2 **Find the value of 'p' for which the following vectors are perpendicular to each other:**

$\vec{A} = \hat{i} + p\,\hat{j} + 3\,\hat{k}$ $\quad\quad$ $\vec{B} = 3\hat{i} + 3\,\hat{j} - 4\,k$

$$\vec{A}\cdot\vec{B} = \left(\hat{i} + P\hat{j} + 3\hat{k}\right)\cdot\left(3\hat{i} + 3\hat{j} - 4\hat{k}\right)$$

$$\vec{A}\cdot\vec{B} = \left(\hat{i} + P\hat{j} + 3\hat{k}\right)\cdot\left(3\hat{i} + 3\hat{j} - 4\hat{k}\right)$$

$$\vec{A}\cdot\vec{B} = 3\left(\hat{i}\cdot\hat{i}\right) + 3\left(\hat{i}\cdot\hat{j}\right) - 4\left(\hat{i}\cdot\hat{k}\right)$$

$$+3P\left(\hat{j}\cdot\hat{i}\right) + 3P\left(\hat{j}\cdot\hat{j}\right) - 4P\left(\hat{j}\cdot\hat{k}\right)$$

$$+9\left(\hat{k}\cdot\hat{i}\right) + 9\left(\hat{k}\cdot\hat{j}\right) - 12\left(\hat{k}\cdot\hat{k}\right)$$

$$\hat{i}.\hat{i} = \hat{j}\cdot\hat{j} = \hat{k}\cdot\hat{k} = 1 \quad\quad \hat{i}.\hat{j} = \hat{j}\cdot\hat{k} = \hat{k}\cdot\hat{i} = 0$$

$$0 = 3 + 3P - 12$$

$$-3 = P$$

3 **Two forces of equal magnitude are acting at a point; find the angle between the two forces when the magnitude of resultant is also equal to the magnitude of either of these forces.**

<table>
<tr>
<td>

Ans **Let A be the magnitude of two vectors $\vec{A}$ and $\vec{B}$ are acting at an angle of θ^0, Assume that the resultant of such two vectors is equal to A**

$|\vec{A}|$ = A $\quad\quad$ $|\vec{B}|$ = A

$|\vec{R}|$ = A

Using cosine law of two vectors

$$|\vec{R}| = \sqrt{A^2 + B^2 + 2\,A\,B\,\cos\theta}$$

Substituting these values in above equation

$$A = \sqrt{A^2 + A^2 + 2\,A\,A\,\cos\theta}$$

$$A = \sqrt{A^2 + A^2 + 2\,A^2\,\cos\theta}$$

</td>
<td>

$$A = \sqrt{2\,A^2 + 2\,A^2\,\cos\theta}$$

Squaring both the sides

$$A^2 = 2\,A^2 + 2\,A^2\,\cos\theta$$

$$A^2 = A^2\,(2 + 2\cos\theta)$$

$$\frac{A^2}{A^2} = (2 + 2\cos\theta)$$

$$1 = 2 + 2\cos\theta$$

$$1 - 2 = 2\cos\theta$$

$$-\frac{1}{2} = \cos\theta$$

$$\theta = \cos^{-1}\left(-\frac{1}{2}\right)$$

θ = 120^0

</td>
</tr>
</table>

4 Find the area of a parallelogram if its two sides are formed by the vectors:

$\vec{A} = 2\hat{i} - 3\hat{j} - \hat{k}$ and $\vec{B} = \hat{i} + 4\hat{j} - 2\hat{k}$

SOLUTION: $\vec{A}\times\vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & -3 & -1 \\ 1 & 4 & -2 \end{vmatrix}$ $= \hat{i}\begin{vmatrix} -3 & -1 \\ 4 & -2 \end{vmatrix} - \hat{j}\begin{vmatrix} 2 & -1 \\ 1 & -2 \end{vmatrix} + \hat{k}\begin{vmatrix} 2 & -3 \\ 1 & 4 \end{vmatrix}$ $\vec{A}\times\vec{B} = \hat{i}\{(-3\times-2)-(4\times-1)\}$ $-\hat{j}\{(2\times-2)-(1\times-1)\}$ $+\hat{k}\{(2\times4)-(1\times-3)\}$	$\vec{A}\times\vec{B} = \hat{i}(6+4) - \hat{j}(-4+1) + \hat{k}(8+3)$ $\vec{A}\times\vec{B} = 10\hat{i} + 3\hat{j} + 11\hat{k}$ $\lvert\vec{A}\times\vec{B}\rvert = \sqrt{(10)^2+(3)^2+(11)^2}$ $\lvert\vec{A}\times\vec{B}\rvert = \sqrt{230}$ Area of parallelogram $= \lvert\vec{A}\times\vec{B}\rvert$ Area of parallelogram $= \sqrt{230}$ Area of parallelogram $= 15.16$

5 If one value of the rectangular components of force of 50N is 25N; find the value of other.

DATA F = 50 N **Suppose the given component is $F_x = 25$ N** **SOLUTION** $\mathbf{F} = \sqrt{\mathbf{F_x^2} + \mathbf{F_Y^2}}$ Squaring both the sidex $(\mathbf{F})^2 = \left(\sqrt{\mathbf{F_x^2} + \mathbf{F_Y^2}}\right)^2$	$\mathbf{F^2} = \mathbf{F_x^2} + \mathbf{F_Y^2}$ $(50)^2 = (25)^2 + \mathbf{F_Y^2}$ $2500 = 625 + \mathbf{F_Y^2}$ $2500 - 625 = \mathbf{F_Y^2}$ $\sqrt{1875} = F_Y$ $43.3\text{ N} = F_Y$

6 Two forces of magnitude 10N and 15N are acting at a point. The magnitude of their resultant is 20N; find the angle between them.

DATA **F_1 = 10 N F_2 = 10 N R = 10 N** $R = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos\theta}$ $R^2 = F_1^2 + F_2^2 + 2F_1F_2\cos\theta$ $(20)^2 = (10)^2 + (15)^2 + 2(10)(15)\cos\theta$ $400 = 100 + 225 + 300\cos\theta$	$400 - 325 = 300\cos\theta$ $75 = 300\cos\theta$ $\cos\theta = \left(\frac{75}{300}\right)$ $\theta = \cos^{-1}(0.25)$ $\theta = 75.5^0$

7 **At what suitable angle is the maximum height of the projectile $\frac{1}{3}$ of its range**

Ans **The horizontal range is given by**

$$R = \frac{v_0^2 \sin 2\theta}{g} \quad \text{----------------(i)}$$

The maximum height attained by the projectile is given by

$$h_{max} = \frac{v_0^2 \sin^2\theta}{2g} \quad \text{------------- (ii)}$$

According to the given condition

maximum height of the projectile = $\frac{1}{3}$ horizontal range of the projectile

$$h_{max} = \frac{1}{3} R$$

$$\frac{v_0^2 \sin^2\theta}{2g} = \frac{1}{3} \times \frac{v_0^2 \sin 2\theta}{g}$$

$$\frac{v_0^2 \sin\theta \sin\theta}{2g} = \frac{1}{3} \times \frac{v_0^2 \, 2\sin\theta \cos\theta}{g}$$

$$\frac{\sin\theta}{2g} = \frac{2\cos\theta}{3g}$$

$$\frac{\sin\theta}{2} = \frac{2\cos\theta}{3}$$

$$\frac{\sin\theta}{\cos\theta} = \frac{2 \times 2}{3}$$

$$\tan\theta = \frac{4}{3}$$

$$\theta = \tan^{-1}\left(\frac{4}{3}\right)$$

$$\theta = \tan^{-1}(1.33)$$

8. **Prove that maximum horizontal range is four times the maximum height attained by the projectile.**

Ans. The maximum horizontal range is given by

$$R = \frac{v_0^2 \, Sin\, 2\theta}{g}$$

$$R_{max} = \frac{v_0^2 \, Sin\, 2(45)}{g} \qquad (\text{ when } \theta = 45^0 \,)$$

$$R_{max} = \frac{v_0^2}{g} \quad \text{.......................(i)}$$

The maximum height attained

$$h_{max} = \frac{v_0^2 \, Sin^2\theta}{2\,g}$$

$$h_{max} = \frac{v_0^2 \, (Sin 45)^2}{2\,g} \quad \text{or} \quad h_{max} = \frac{v_0^2 \left(\frac{1}{\sqrt{2}}\right)}{2\,g}$$

$$h_{max} = \frac{v_0^2 \left(\frac{1}{2}\right)}{2\,g} \quad \text{or} \quad h_{max} = \frac{v_0^2}{4\,g}$$

$$h_{max} = \frac{1}{4} \, x \, \frac{v_0^2}{g}$$

$$h_{max} = \frac{1}{4} \, x \, R_{max}$$

$$R_{max} = 4\, h_{max}$$

9. **in the game of cricket, why is it easy to catch a ball of high trajectory.**

Ans When the batsman hits the cricket ball high up in the air then ball moves along the parabolic trajectory, at the high trajectory cricket ball takes longer time to reach the ground and thus the fielder on the ground has enough time to adjust himself under the trajectory of the ball and catch it very easily.

10 **A martar shell is fired at a ground level target 490m away with an initial velocity of 98m/s. Find the two possible values the launch angle. Calculate the minimum time to hit the target.**

DATA

Horizontal Range R_H = 490 m

Initial velocity V_o= 98 m/s

Possible values of launch angles = ?

Minimum time to hit the target T = ?

Solution:

$$R_H = \frac{V_o^2}{g} \sin 2\theta$$

$$490 = \frac{(98)^2}{9.8} \sin 2\theta$$

$$\sin 2\theta = \frac{490 \times 9.8}{(98)^2}$$

$$\sin 2\theta = \frac{4802}{9604}$$

$$\sin 2\theta = 0.5$$

$$\therefore 2\theta = \sin^{-1}(0.5)$$

$$2\theta = 30°$$

$$\theta = 15°$$

The second possible launch angle can be calculated by:

Second possible launch angle

$$\theta = 90° - \theta$$

$$\theta = 90° - 15$$

$$\theta = 75°$$

Hence the two possible launch angles are **15°** and **75°.**

Minimum time

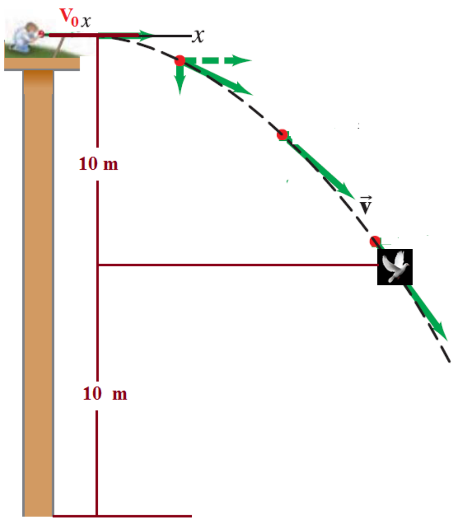
$$T = \frac{2 v_o \sin\theta}{g}$$

$$T = \frac{2 \times 98 \times \sin 15°}{9.8}$$

∴ T = 5.176 sec

The projectile takes minimum time of 5.176 sec. at 15°

11 **A bullet was fired horizontally with 20 m/s from the top of a building 20m high. When the bullet was 10 m above the ground, incidentally it hits a bird. Find the time taken to hit the bird and the velocity of bullet when it hits the bird.**



DATA:

Initial horizontal velocity v_{ox} = v_x = 20 m/s

Height of the building = 20 m

Height at which bird was hit = 10 m

Net vertical displacement

y = 10 m – 20 m = -10 m (downward, along –y axis)

Initial vertical velocity V_{oy} = 0

Time taken t = ?

SOLUTION:

$$y = v_{oy} t - \frac{1}{2} g t^2$$

$$-10 = 0 - \frac{1}{2} \times 9.8 t^2$$

$$-10 = -4.9 t^2$$

$$t^2 = \frac{10}{4.9}$$

t = 1.429 s

Similarly

$$V_y = V_{oy} - gt$$

$$V_y = 0 - (9.8 \times 1.429)$$

$$V_y = -14 \text{ m/s}$$

(in downward direction) Net velocity with which the bullet hits the bird is given by:

$$V = \sqrt{V_x^2 + V_y^2}$$

$$V = \sqrt{(20)^2 + (-14)^2}$$

$$V = \sqrt{400 + 196} = \sqrt{596}$$

V = 24.41 m/s

12. **What is take off speed of a locust if it's launching angle is 55° and its range is 0.8 m?**

DATA: $\theta = 55°$ $R = 0.8$ m $V_o = ?$ $g = 9.8$ m/sec^2 **SOLUTION:** $R = \frac{V_o^2}{g} \sin 2\theta$	$0.8 = \frac{V_o^2}{9.8} \sin 2(55°)$ $0.8 \times 9.8 = V_o^2 \sin 110°$ $7.84 = V_o^2 (0.939)$ $\frac{7.84}{0.939} = V_o^2$ $V_o = \sqrt{8.349} = 2.889$ m/s

13. **Two possible angles to hit a target by a mortar shell fired with initial velocity of 98 m/s are 15° and 75°. Calculate the range of projectile and the minimum time required to hit the target.**

DATA: Initial velocity $v_o = 98$ m/s Angles for same range $\theta = 15°$ & $75°$ Range of projectile R = ? Minimum time required t = ? **SOLUTION:** Range of a projectile is given by; $R = \frac{v_o^2}{g} \sin 2\theta$ $R = \frac{(98)^2}{9.8} \sin 2 \times 15° \text{(range at } 15°)$ $R = \frac{9604}{9.8} \sin 30°$	$R = \frac{9604 \times 0.5}{9.8}$ R = 490 m Range of the projectile is 490 m for both the angles. The projectile takes minimum, time to hit the target when it is fired at smaller of the two possible angles, hence $T = \frac{2 v_o \sin\theta}{g}$ $T = \frac{2 \times 98 \times \sin 15°}{9.8}$ $\therefore$ T = 5.176 sec

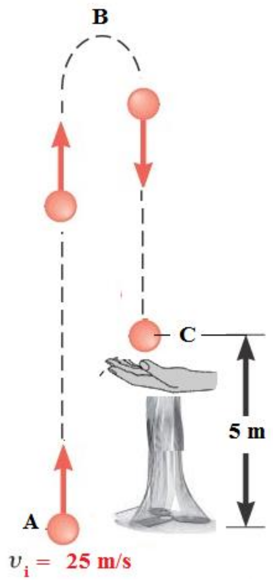
14 **A ball is thrown vertically upward from the ground with a speed of 25m/s. On the way down it is caught at a point 5m above the ground. How long did the trip take?**

Data:

$v_i = 25\ ms^{-1}$

$g = 9.8\ ms^{-2}$

t = ?



Solution:

(i) to find t_1

$v_f = v_i + at$

a = -g = -9.8 m/sec^2

$V_f = V_i + g\,t$

$0 = 25 + (-9.8)t$

$9.8\ t = 25$

$t = 2.55\ s$

To find the height of the ball

$2gs = V_f^2 - V_i^2$

$2(-9.8)h = (0) - (25)^2$

$-19.6h = -625$

$h = \frac{625}{19.6}$

$h = 31.887\ m$

Height point B to C is

H = h – 5

H = 31.887 – 5

H = 26.887 m

Time between B to C

s =H = **26.887** m

$v_i = 0$

$a = 9.8\ m/s^2$

$S = v_i t + \frac{1}{2} g t^2$

$26.887 = (0\,xt) + \frac{1}{2}(9.8)t^2$

$\frac{26.887}{4.9} = t^2$

$t_2 = 2.34\ s$

total time taken

$t = 2.55 + 2.34 = 4.89\,s$

15 A boy throws a ball upward form the top of a tower with a speed of 12m/s. On the way down it just misses the thrower and falls to the ground 50m below. Find how long the ball remains in the air.

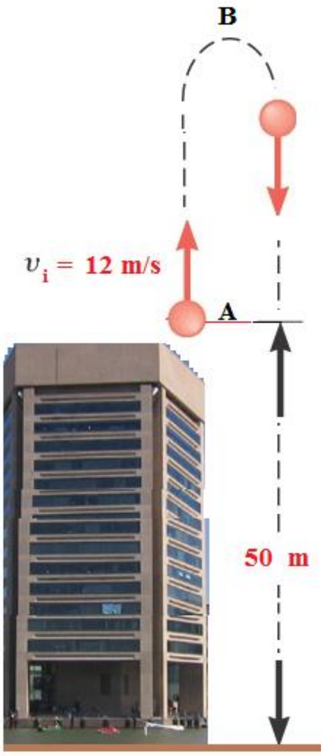
Data:

$v_i = 14.7\, m/sec$

H = 49 m

(i) t_1 = ? (ii) s_1 = ?

(iii) T = ? (iv) v_f = ?



Solution:

(i) to find t_1

$$V_f = V_i + g\,t$$

$$0 = 12 + (-9.8)t$$

$$9.8\ t = 12$$

$$t = 1.22\ s$$

(ii) **To find height between A and B:**

$$2gs = V_f^2 - V_i^2$$

$$2(-9.8)h = (0) - (12)^2$$

$$-19.6h = -144$$

$$h = \frac{144}{19.6}$$

$$h = 7.346\ m$$

Height point B to C is

H = h + 50

H = 7.347 + 50

H = 57.347 m

Time between B to C

s =H = **57.347** m

$v_i = 0$

$a = 9.8\, m/s^2$

$$S = v_i t + \frac{1}{2} g t^2$$

$$57.347 = (0\,xt) + \frac{1}{2}(9.8)t^2$$

$$\frac{57.347}{4.9} = t^2$$

$$\sqrt{\frac{57.347}{4.9}} = t$$

$$t_2 = 3.42\ s$$

total time taken

$$t = 1.22 + 3.42 = 4.62\ s$$

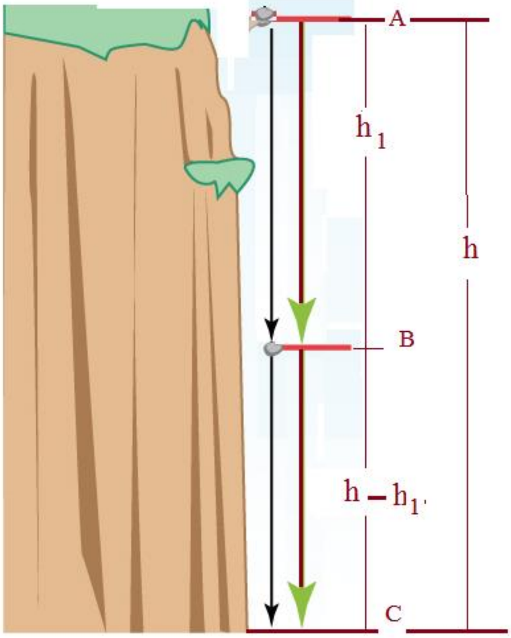
16 A stone is dropped from the peak of a hill. It covers a distance of 30m in the last second of its motion, find the height of the peak.

<table>
<tr>
<td>

<u>DATA</u>

$V_i = 0$

Last second distance S = 30 m



<u>The distance covered by the stone in t second</u>

$S = v_i t + \frac{1}{2} g t^2$

$h = (0xt) + \frac{1}{2}(9.8)t^2$

$h = 4.9t^2 \ldots\ldots\ldots\ldots\ldots\ldots (i)$

</td>
<td>

<u>The distance covered by the stone in (t-1) second</u>

$S = v_i t + \frac{1}{2} g t^2$

$h_1 = v_i t + \frac{1}{2} g (t-1)^2$

$h_1 = (0 \times t) + \frac{1}{2}(9.8)(t-1)^2$

$h_1 = 4.9(t-1)^2 \ldots\ldots\ldots\ldots (ii)$

From the given condition

$h - h_1 = 30$

$h - h_1 = 4.9(t-1)^2 - 4.9t^2$

$30 = 4.9t^2 - 4.9(t^2 - 2t + 1)$

$30 = 4.9t^2 - 4.9t^2 + 9.8t - 4.9$

$30 = 9.8t - 4.9$

$30 + 4.9 = 9.8t$

$3.56s = t$

Put t = 3.56 in equation (i), we get

$h = 4.9(3.56)^2$

$h = 62m$

</td>
</tr>
</table>